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JOHN SPELLMAN
Governor

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
7272 Cleanwater Lane, LU-11 • Olympia, Washington 98504 • (206) 753-2353

M E M O R A N D U M
October 13, 1983

To: Roger Ray

From: Bill Yake BY

Subject: Chewelah Class II Inspection and Receiving Water Report

INTRODUCTION

Chewelah (population 2,029) is served by a wastewater treatment plant (WTP) discharging to the Colville River (river mile 38.3). The treatment facility, which consists of a series of three unaerated lagoons, was constructed approximately 25 years ago.

A Class II (source compliance) inspection and receiving water study were conducted June 20-22, 1983, at the request of the Eastern Regional Office (ERO) of the Washington State Department of Ecology (WDOE). The purposes of this work were several:

1. Determine if the plant is complying with its NPDES permit limits;

2. Assess the adequacy of various data transmitted in the Discharge Monitoring Reports (DMRs). Flow-monitoring practices, sampling procedures, and analytical procedures at the facility have raised questions regarding the adequacy and accuracy of these data. Recommendations for eliminating deficiencies were also requested;

3. Assess, to the extent possible, the efficiency of wastewater treatment at the Chewelah WTP and the implications of increasing the amount of wastewater treated by the lagoons; and

4. Assess water quality in the Colville River, focusing on the impacts of effluent discharged from the Chewelah WTP. Estimate impact under critical conditions (summer low flow).

There are pending developments in the Chewelah area which could potentially increase wastewater flows to the Chewelah WTP. The information contained in this report may be helpful in addressing questions regarding possible WTP upgrade or expansion.

Participating in the survey were Kevin Kiernan and Bill Yake (WDOE, Water Quality Investigations Section). Substantial and valuable assistance was provided by Roger Ray and Jim Prudente. The aid and cooperation of Bill Weaver (Public Works Division), Neel Christian (chief operator), and Ted Ocilvie (acting operator) are much appreciated.

The results of this study are reported in two sections: Part I - Chewelah WTP Class II Survey; and Part II - Chewelah Receiving Water Study.

Part I - Chewelah WTP Class II Survey

The flow diagram for the Chewelah WTP is illustrated in Figure 1. Incoming sewage flows through a Parshall flume and is then routed sequentially through three shallow lagoons. The effluent from the third pond overflows a weir; chlorine is then added and the effluent routed to the chlorine contact chamber. At the end of the contact chamber, effluent overflows a rectangular weir and is routed through a subsurface discharge pipe to the Colville River. The facility has little apparent operational flexibility. The flow pattern is fixed and there is no mechanical aeration. Additionally, there is no operational flow totalizer and plant flow is obtained only by making instantaneous head measurements at the contact chamber weir. The plant has no composite sampling equipment and very restricted laboratory capabilities. Biochemical oxygen demand (BOD), suspended solids, and fecal coliform tests are all performed at the Colville WTP laboratory.

During the inspection, it was apparent that only Pond #1 was supporting substantial algae growth; suspended solids and dissolved oxygen concentrations in Ponds #2 and #3 were quite low. A substantial portion of Pond #3 was covered with duckweed (*Lemna sp.*).

Sampling Methodology and Analytical Results

Composite samples (24-hour) were obtained at the influent, Pond #3 (unchlorinated) effluent, and chlorinated effluent for the full range of laboratory analyses. The influent and unchlorinated (Pond #3) effluent samples were split with Chewelah plant personnel for analysis at the Colville laboratory. Grab samples of Pond #1 and #2 effluents were also obtained for laboratory analysis. Fecal coliform grab samples were collected at the outfall weir of the chlorine contact chamber. Residual chlorine concentrations were measured concurrently with the collection

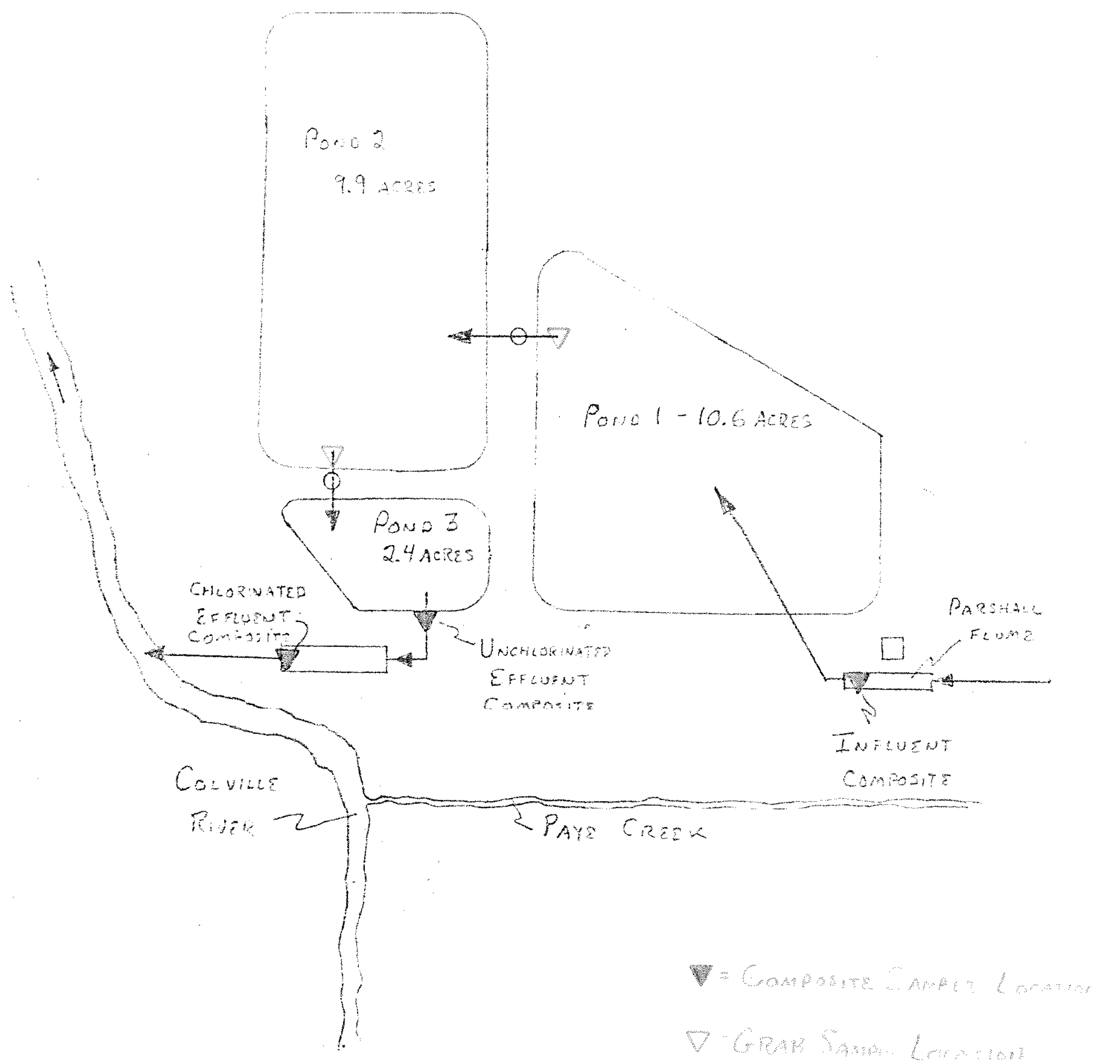

Figure 1. Colville WTP and sample locations.

of fecal coliform samples. Field tests (temperature, pH, specific conductivity, and dissolved oxygen) were conducted on grab samples collected from each of the sampling sites noted above. Table 1 contains specific information regarding times, dates, locations, and analyses pertinent to each of these samples. Sample locations are depicted in Figure 1. Analytical results are summarized in Table 2.

Influent and unchlorinated (Pond #3) effluent composite samples were split for analysis at the Colville treatment plant. Two fecal coliform samples were obtained concurrently for WDOE and Chewelah/Colville analysis. BOD, suspended solids, and fecal coliform analyses of Chewelah wastewater samples are routinely conducted at the Colville facility.

Table 3. Chewelah/Colville laboratory results.

	Influent	Unchlorinated Effluent	Chlorinated Effluent	Percent Removal
BOD_5 (mg/L)	64	3		97%
TSS (mg/L)	36	2		94%
Fecal Coliform (#/100 mL)			0	

The Chewelah plant did not have an operative flow meter or totalizer. The plant's influent flow meter, designed to use the Parshall flume as a primary flow-measuring device, had been defunct for many years and the plant operators had been using head measurements at the contact chamber effluent weir to estimate flow. To provide a more accurate measure of plant flow, a portable Manning dipper flow meter was installed at the influent Parshall flume. The flow trace for the 24-hour sampling period is shown in Figure 2.

Findings

The status of the Chewelah NPDES permit is somewhat complicated. A permit (WA-002360-4) and an Order (Docket No. DE 77-286) were issued essentially concurrently in June of 1977. The permit required standard secondary treatment standards (30 mg/L BOD and suspended solids, 85 percent removal) while the order relaxed these limits to monthly average concentrations of 50 mg/L BOD and suspended solids with no percent removal requirements. The permit initially expired on June 30, 1982, but was extended indefinitely by a letter dated July 15, 1982. Thus it appears (Roger Ray, personal communication) that the limits listed in the order are those which are currently in effect.

Table 1. Composite and grab sample information.

24-hour Composite Sample Information

Sample Name/Aliquot	Date and Time Installed	Location
1. Influent Aliquot - 230 mL/30 min	6/21 - 1000	Influent Parshall flume
2. Unchlorinated (Pond 3) Eff. Aliquot - 230 mL/30 min.	6/21 - 1030	Downstream side of Pond #3 effluent weir
3. Chlorinated Effluent Aliquot - 230 mL/30 min.	6/21 - 1045	Immediately upstream of contact chamber effluent weir

Grab Sample Information

Sample Location	Date and Time	Laboratory Analysis
Pond #1 Effluent	6/22 - 0850	BOD, COD, solids (4), nutrients (5), turbidity, conductivity
Pond #2 Effluent	6/22 - 0900	BOD, COD, solids (4), nutrients (5), turbidity, conductivity
Chlorinated Effluent	6/21 - 1045 6/22 - 0930	Fecal Coliform Fecal Coliform

Field Data

Sample Location	Date and Time	Field Analysis
Influent	6/21 - 1000 6/22 - 0800 Composite	pH, D.O., temp., cond. pH, D.O., temp., cond. pH, cond.
Pond #1 Effluent	6/22 - 0850	pH, D.O., temp., cond.
Pond #2 Effluent	6/22 - 0900	pH, D.O., temp., cond.
Unchlorinated (Pond #3) Eff.	6/21 - 1030 6/22 - 0910 Composite	pH, D.O., temp., cond. pH, D.O., temp., cond. Cond.
Chlorinated Effluent	6/21 - 1045 6/22 - 0930 Composite	pH, temp., cond., TCR Temp., cond., TCR pH

Table 2. Chewelah WTP Class II survey results - WDOE laboratory.

Parameter	Influent	Pond #1 Effluent	Pond #2 Effluent	Pond #3 Effluent	Chlorinated Effluent	Monthly Average Permit Limits
Flow (MGD)	.41					.45
BOD_5 (mg/L)	72	26†	6 Est.†	5 Est.	7 Est.	30
(lbs/day)	246	89	21 Est.	16 Est.	24 Est.	51
(% Removal)					90% Est.	85%
Carbonaceous BOD_5 (mg/L)					4 Est.	
Suspended Solids (mg/L)	67	26†	5†	4	1	30
(lbs/day)	229	89	17	14	3	51
(% Removal)					96%	85%
COD (mg/L)	150	100†	42†	42	38	
pH (S.U.)	7.7 7.9* 7.8* 8.0**	8.8† 8.9*	8.1† 8.2*	8.1 8.0* 8.0*	8.1 7.9*	6.5-8.5
Dissolved Oxygen (mg/L)	3.2* 4.6*	11.3*	3.9*	2.7* 3.4*		
Diss. Oxygen (% Sat.)	34%* 47%*	128%*	44%*	30% 38%		
Specific Conductivity (μmhos/cm)	599 725* 800* 580**	587† 580*	619† 570*	612 551* 520* 650**	610	
Temperature (°C)	15.4* 13.9*	18.8*	18.0*	18.0* 18.2*	17.8* 17.9*	
Turbidity (NTU)	33	15†	4†	3	2	
Total Solids (mg/L)	490	380†	390†	400	440	
T. Non-vol. Solids (mg/L)	310	250†	280†	290	300	
Total Susp. Solids (mg/L)	67	26†	5†	4	1	30
TNVSS (mg/L)	8	2†	3†	2	1	
NH_3-N (mg/L)	8.2	4.0†	4.4†	3.6	3.9	
NO_2-N (mg/L)	<0.1	<.05†	<.05†	.05	<.05	
NO_3-N (mg/L)	<0.1	<.05†	<.05†	.05	.25	
O-PO_4-P (mg/L)	1.9	3.3†	1.4†	1.1	1.1	
T-PO_4-P (mg/L)	3.6	3.8†	1.6†	1.2	1.3	
T. Chlorine Resid. (mg/L)					2.5* 1.0*	
Fecal Coliform (#/100 mL)					<1 6 Est.	200

† = Grab sample; lab analysis
Est = Estimated
* = Grab sample; field analysis
** = Composite sample; field analysis

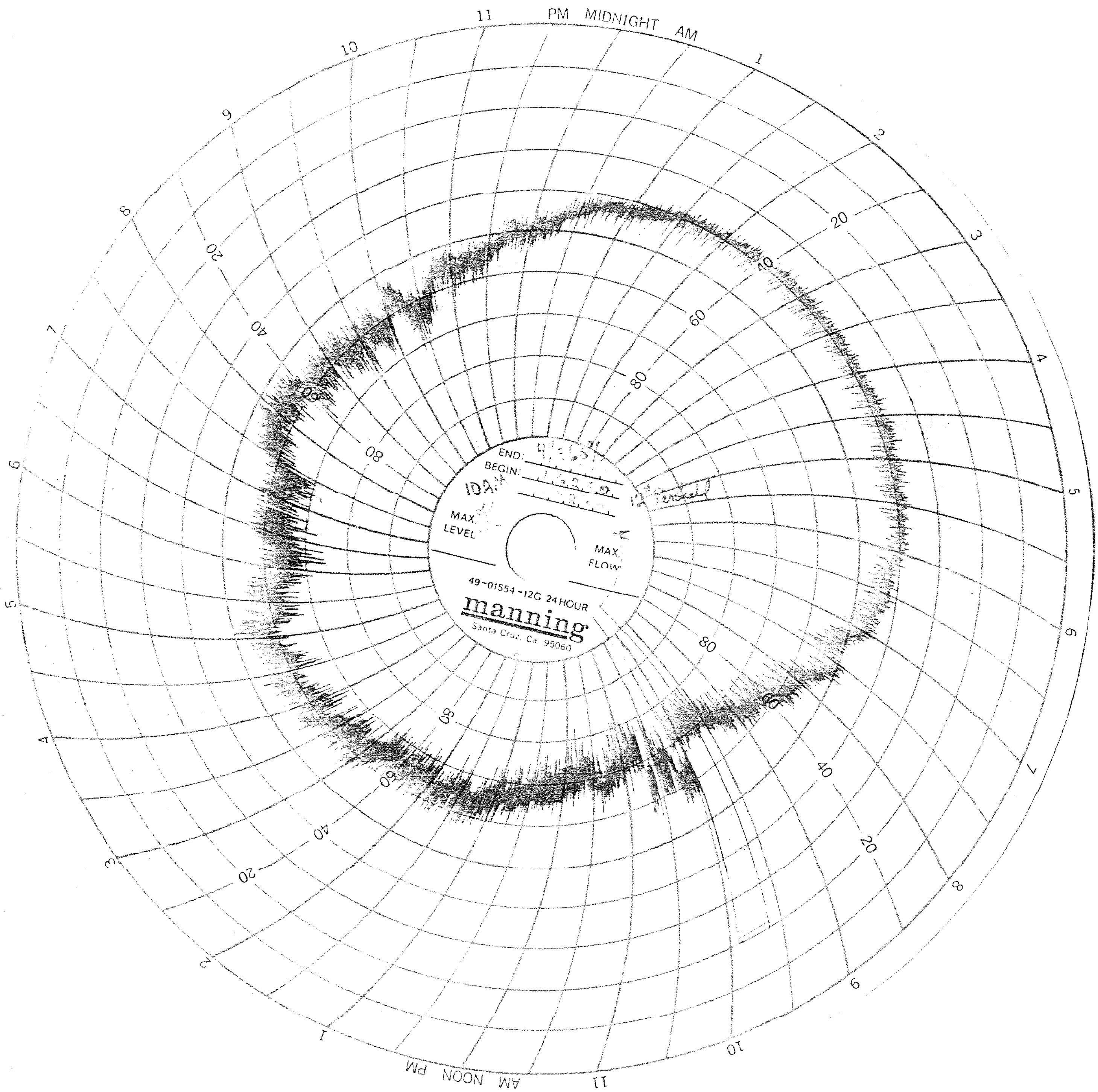

Figure 2. Chewelah WTP influent flow recorder.

It should be noted that more recent permits issued to small (less than 2 MGD) municipal lagoon systems in Washington State have generally specified monthly average limits of 30 mg/L for BOD, 75 mg/L for suspended solids, and 85 percent removal for BOD in accordance with 40 CFR 133:103c.

Table 4 compares data obtained during this survey with both the original permit limits and the order limits.

Other than chlorine residual (see Review of Analytical Procedures), the only parameter approaching permit or order limits was flow with a measured 24-hour flow of 0.41 MGD vs. a monthly average limit of 0.45 MGD. Based on Figure 2 (flow meter script chart), the overnight flow rate was about 0.2 MGD. This should be approximately equivalent to infiltration/inflow (I/I). Although the flows measured at the plant and subsequently reported on the DMRs are somewhat questionable and probably underestimate plant flow (see Review of Flow-Measuring Procedures), excessive flows at the Chewelah plant appear to be a chronic problem. This problem appears to be especially severe during the late winter and early spring when DMRs report monthly average flows approaching 0.9 MGD. These flows are four to five times higher than the 0.2 MGD one would expect based on the standard estimate of 100 gallons/capita/day for a service population of 2,000.

The most obvious implication of this excess flow is that it drastically reduces the detention time of the wastewater in the lagoon system. Because the high flows to the plant occur when the temperature of wastewaters in the lagoon is low, treatment efficiency would be expected to deteriorate seriously during the winter and spring. Although inadequate sampling procedures at the Chewelah plant cast particular doubt on the representativeness of influent BOD and suspended solids results, DMRs appear to show very weak influent strength and poor removal efficiencies (less than 50 percent) during the months of January to April.

The possibility of increasing wastewater loadings to the Chewelah lagoons has been broached by Chewelah town officials. Three general areas need to be considered prior to approving such a request:

1. Will the plant be able to meet appropriate permit limits?

2. Will the plant be operating within design parameters? and

3. Will there be adverse impacts on the receiving water?

The final question will be addressed in the second portion of this report. Discussion regarding the first two questions follows:

<u>Will the plant be able to meet appropriate permit limits?</u> Initially, it appears that the order or permit should be modified to align

Table 4. Chewelah WTP permit compliance.

	WDOE Results		Permit Limits		Order Limits	
	Unchlorinated Effluent	Chlorinated Effluent	Weekly Limits	Monthly Limits	Weekly Limits	Monthly Limits
Flow (MGD)	.41	.41	--	.45	--	.45
BOD_5 (mg/L)	5 est.	7 est.	45	30	75	50
(lbs/day)	16 est.	25 est.	77	51	290	190
(percent removal)	93% est.	90% est.	--	85%		
TSS (mg/L)	4	1	45	30	75	50
(lbs/day)	14	3	77	51	290	190
(percent removal)	94%	96%	--	85%		
pH (S.U.)	8.0-8.1	7.9-8.1	6.5-8.5		6.5-8.5	
Fecal Coliform (col/100 mL)		<1 6	400		200	
Total Chlorine Residual (mg/L)		1.0-2.5			0.1-0.5	

Est. = Estimated

with standard Washington State, small stabilization pond limits (i.e., monthly average BOD limits of 30 mg/L and 85 percent removal, effluent suspended solids averages of 75 mg/L). A flow limit should be determined based on the hydraulic design capacity of the lagoons (see next section). Under current (high I/I) conditions, it is unlikely that the lagoons would meet these permit limits for flow and 85 percent BOD removal during the late winter and early spring. Substantial improvements in flow measurement and sample collection at the plant would be necessary before making an accurate assessment of current efficiency of the facility.

Will the plant be operating within design parameters? Probably the two most critical design parameters for stabilization ponds are areal BOD loading and detention time. Areal BOD loading does not appear to be a current problem. WDOE design criteria (WDOE, 1978) state "design loading should not exceed 20 pounds BOD per acre per day on a total pond area basis and 50 pounds BOD per acre per day to any single pond." Based on the results of this inspection and a standard BOD load based on 0.18 lb BOD/capita/day (Metcalf and Eddy, 1979), the current areal BOD loading is 10.7 to 15.9 lbs/acre for total pond area and 23 to 34 lbs/acre to a single pond.

Under conditions of normal wastewater strength, detention time in stabilization ponds is usually not limiting and, in fact, current state design criteria (WDOE, 1978) do not address detention times directly. Unfortunately, the high I/I flows experienced at the Chewelah plant coupled with apparently shallow ponds (bankside observation indicated depths of $\leq$ 2 feet in many areas) may well make detention time a critical design parameter. Literature values for adequate detention times include 20 to 180 days (Benefield and Randall, 1980) and "generally greater than 30 days" (WPCF, 1959 - apparently the same year the ponds were built). Theoretically, stabilization pond detention times should be at least as long as those for aerated lagoons. Using the appropriate design equations (WDOE, 1978, p. 150-151), pond temperatures of 2°C (based on wintertime DMR data), and an 85 percent BOD removal rate, this works out to a minimum detention time of 28 days.

To determine the status of the Chewelah ponds with regard to detention times, accurate estimates of pond depths and plant flows are required. We suggest that prior to making any decisions regarding increased loadings to the ponds, the applicant (Chewelah) provide accurate measurements of pond depth and a year's worth of accurate wastewater flows to the ponds.

In addition, the source of excess (I/I) flows should be investigated and potential solutions to this problem identified. Until excess flows are reduced, it may remain difficult to achieve adequate wastewater treatment during the late winter and early spring.

Three additional observations based on survey results bear noting:

1. The organic loading measured during the survey was substantially less than one would expect from a service area the size of Chewelah. Based on an average organic load of 80 g BOD/capita/day (.18 lb/capita/day) (Metcalf & Eddy, 1979), a load of 365 lbs BOD/day would be expected. The actual measured influent load was only 246 lbs/day or only about 67 percent of the expected load. This may indicate that up to 1/3 of the population of Chewelah is not being served by the sewage system.

2. Dissolved oxygen concentrations and suspended solids (thus algae) concentrations in Ponds #2 and #3 were quite low (Table 2). Generally, one would expect high productivity in stabilization ponds, particularly during the middle of the growing season. However, only Pond #1 was visually green and had dissolved oxygen concentrations (11.3 mg/L; 128 percent saturation) approaching or exceeding saturation. The reason for the apparent lack of algal growth in Ponds #2 and #3 is not known.

3. During the inspection, the efficiencies of the ponds in terms of BOD and suspended solids removal were excellent. The low concentrations of dissolved oxygen in Ponds #2 and #3 did not appear to be inhibiting treatment in any way and the lack of high-standing algal crops allowed very low effluent suspended solids concentrations.

Review of Sampling, Analysis, and Flow-measurement Procedures; Split Sample Results

Flow Measurement: At the time of the inspection, plant operators were measuring plant flows at a rectangular weir at the discharge end of the chlorine contact tank. There are several problems with these flow measurements:

1. The weir is quite long (about 4-1/2 feet) and thus water depth (head) measurements are small; about 1-3/8 inches during the inspection. Therefore, small errors in head measurement may lead to fairly substantial errors in flow estimation.

2. Head measurements were being made directly above the weir rather than a foot or so upstream. This leads to an underestimation of flow.

3. Instantaneous flow measurements do not provide an accurate 24-hour total flow.

The Chewelah plant was constructed with a Parshall flume at the influent. A flow-measuring device and totalizer were also provided but have not been operative for a number of years. The flume is well constructed and should provide accurate flows if a flow-measuring device and totalizer were installed. Because accurate flows are critical for assessing organic and hydraulic plant loads as well as quantifying I/I problems, we recommend:

1. Chewelah should install and accurately calibrate a continuous flow meter with script chart recorder and flow totalizer. This meter should be installed using the Parshall flume as a primary flow-measuring device.

2. Flows reported on the DMRs should be totalized flows for 24-hour periods.

3. Until this flow meter is installed, flow measurements at the effluent weir could continue; however, care should be taken to obtain precise head measurements and these measurements should be made at least eight inches upstream from the weir.

Sampling Procedures

The primary problem with sampling procedures is that the Chewelah facility has no means of obtaining 24-hour composite samples. Currently, only grab samples are obtained. Composite samples are required for determining permit compliance with BOD and suspended solids limitations. It is particularly critical that influent BOD and suspended solids samples be collected as composites because not only does influent wastewater strength vary substantially during the day, but accurate estimates of organic loading are critical in determining the status of the ponds with respect to design criteria.

Other sampling procedures appeared adequate; therefore, our only recommendation regarding sampling is:

1. Chewelah should obtain influent and effluent samplers capable of obtaining 24-hour composite samples.

Analytical Procedures

Field tests (D.O., pH, chlorine residual, and temperature) are performed on site by Chewelah plant operators, while samples for laboratory analyses (BOD, suspended solids, fecal coliform) are sent to the Colville WTP laboratory. Because laboratory analyses are not performed at Chewelah, methods were not reviewed with the operators. However, composite samples were split so that both the WDOE laboratory and the Colville laboratory could analyze the samples for BOD and suspended solids. In addition, simultaneous fecal coliform samples were obtained for analysis by both laboratories. Table 5 compares the results of these analyses:

Table 5. Split and simultaneous samples results; comparison of results.

Sample Location	Influent		Unchlorinated Effluent		Chlorinated Effluent	
Sample by	WDOE		WDOE		WDOE	Chewelah
Analyses by	WDOE	Colville	WDOE	Colville	WDOE	Colville
BOD_5 (mg/L)	72	64	5*	3	7*	
TSS (mg/L)	67	36	4	2	1	
Fecal Coliform (col/100 mL)					6*	0

*Estimate

In general, comparability appears to be adequate except for the influent suspended solids analysis.

Field tests were discussed briefly with the operators and only one major problem was noted: operators were testing for free chlorine rather than total chlorine residual. The DPD method was being used; therefore, color development based on the addition of both #1 and #3 tablets; or a #4 tablet alone should be used to obtain total chlorine residual. Because of this error, the 0.1 and 0.2 mg/L chlorine residuals reported historically in the DMRs are more equivalent to 2.5 mg total chlorine residual/L -- well above the range specified in the order (0.1 to 0.5 mg/L). After discovering this, the operators turned down the chlorine feed rate for the second day of the survey and the chlorine residual concentrations fell from 2.5 to 1.0 mg/L. Disinfection was still effective at this lower concentration. Because the Chewelah plant has a very large, well-designed chlorine contact chamber, it may well be possible for them to maintain adequate disinfection while keeping chlorine residuals in the required 0.1 to 0.5 mg/L range.

As an indication of the accuracy of pH and D.O. values obtained at the Chewelah facility, Table 6 compares values obtained by ourselves and the plant operators on the morning of June 22. WDOE samples were taken about one hour later than the Chewelah samples; therefore the comparison provided on Table 6 is only approximate. It does, however, indicate that pH measurements at the plant are quite accurate. D.O. measurements appear to be at least reasonably accurate.

Table 6. Field analysis comparsion; June 22, 1983.

	pH		Dissolved Oxygen (mg/L)	
	Analysis By		Analysis By	
Sample Location	WDOE	Chewelah	WDOE	Chewelah
Influent	7.8		4.6	5.2
Pond #1 Effluent	8.9	8.7	11.3	12.1
Pond #2 Effluent	8.2	8.0	3.9	4.5
Pond #3 Effluent	8.0	7.8	3.4	4.8

Based on our somewhat cursory review, field analyses at the facility appear to generally be adequate, with the exception of chlorine residual testing. The following recommendations are made regarding residual chlorine analysis:

1. Total residual chlorine concentrations should be measured and reported. Use either the #4 DPD tablets or the #1 and #3 tablets.

2. Continue to reduce chlorine feed until residual concentrations fall within the order limits of 0.1 to 0.5 mg/L. Maintain these residuals as long as disinfection remains adequate (i.e., mean monthly fecal coliform counts of less than 200 col/100 mLs).

Recommendations

Based on the results of this inspection and review of pertinent material (DMRs, permit, etc.), the following recommendations appear warranted:

1. The NPDES permit or accompanying order should be modified to reflect current WDOE practice with regard to small (less than 2 MGD) lagoons and stabilization ponds (i.e., mean monthly limits of 30 mg BOD/L; 85 percent BOD removal; and 75 mg TSS/L).

2. Flow-monitoring procedures at the Chewelah facility should be improved:

   a. An accurate flow-measuring device should be installed at the influent Parshall flume. This device should have both script chart and totalizer capabilities.

   b. Flows reported on the DMRs should be totalized flows for 24-hour periods.

   c. Until this flow meter is installed, flow measurements at the effluent weir may continue. However, these flows should be calculated from precise head measurements obtained at least eight inches upstream from the weir.

3. Twenty-four-hour composite samples of influent and effluent should be obtained for determining compliance with BOD and suspended solids limits. To facilitate this, Chewelah should obtain automatic 24-hour composite samplers.

4. Prior to making any decisions regarding possible increases in loadings to the ponds, the applicant (Chewelah) should provide to WDOE the following:

   a. Accurate measurements of the depth profiles of each of the three ponds;

   b. One year's worth of accurate wastewater flows to the ponds (these data should be generated after installation of the flow meter noted in #2, above);

   c. One year's worth of accurate BOD loading data based on analyses of 24-hour composite samples obtained weekly in compliance with the permit; and

   d. The results of an investigation into the sources and possible solutions to the sources of excessive infiltration and inflow to Chewelah's collection system.

5. Chlorine residual measurement and chlorine feed should be modified as follows:

   a. Total residual chlorine concentrations should be measured and reported using either the #4 DPD tablet or the #1 <u>and</u> #3 tablets.

b. Reduce chlorine feed until total chlorine residuals fall within the range specified by the order (i.e., 0.1 to 0.5 mg/L). Maintain these residuals as long as disinfection remains adequate (i.e., mean monthly field coliform counts of less than 200 col/100 mLs).

Part II - Receiving Water Survey: Water Quality Assessment of Colville River Drainage near Chewelah, Washington

Introduction

Concurrently with sampling conducted at the Chewelah wastewater treatment plant, an abbreviated receiving water survey was conducted, primarily to assess the impacts of the treated wastewater on the Colville River. In addition, sampling sites on Paye and Chewelah creeks were sampled to provide information on other possible impacts on surface water quality near Chewelah. The study area is shown in Figure 3.

Study Methodology

A total of eight surface water sites were sampled: four on the Colville River; two on Chewelah Creek; and two on Paye Creek. Station names and numbers are given in Table 7; Figure 3 displays the locations of the sampling sites. Stations CO-1 corresponds to historical ambient monitoring station 59A130 (Colville River at Chewelah).

As noted in Part I, grab and composite samples were obtained at five locations in the Chewelah WTP. Only the data from the unchlorinated and chlorinated effluent samplers are included in Table 7.

At each station, field tests were conducted for temperature, specific conductivity, pH, and dissolved oxygen (Winkler method, azide modification). Grab samples were obtained for additional laboratory water quality analyses. Laboratory analyses included tests for ammonia, nitrite, nitrate, orthophosphate, total phosphate, fecal coliform bacteria, chemical oxygen demand (COD), various solids fractions, and turbidity. Percent dissolved oxygen saturation and un-ionized ammonia concentrations were calculated based on field and laboratory results for relevant parameters.

Flows were calculated at stations CH-1, CH-2, and P-2 using cross-sectional velocity and depth measurements obtained using a Marsh-McBurney magnetic flow meter and top-setting rod. A similar flow measurement was

Table 7. Summary of water quality data: Colville River system near Chewelah.

Station Number	Station Name	Date	Time	Flow (cfs)	D.O. (mg/L)	D.O. (% Sat.)	Temp. (°C)	pH (S.U.)	Sp. Cond. (µmhos/cm)	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	O-PO_4-P (mg/L)	T-PO_4-P (mg/L)	% Un-ion.	Unionized NH_3-N (mg/L)	Total Sol. (mg/L)	TNVS (mg/L)	TSS (mg/L)	NVSS (mg/L)	Turb. (NTU)	Fecal Coliform (#/100 mL)	TCR (mg/L)	BOD (mg/L)	COD (mg/L)
CH-1	Chewelah Creek	6/21	0740	53																					
	Upstream	6/21	1500		10.1*	99.0%	12.0*	8.5*/7.9	155*/167	<.01	<.01	.28	.02	.04	6.5%	.000	130	93	10	10	6	210			10
CH-2	Chewelah Creek	6/20	1730		10.1*	99.7%	12.3*	8.3*	165*																
	Downstream	6/21	1520	43	10.3*	101.7%	12.3*	8.5*/8.1	175*/162	<.01	<.01	.26	.02	.04	6.6%	.000	140	110	19	10	6	130			14
P-1	Paye Creek, Upstream	6/21	1445	2.9	8.7*	86.1%	12.4*	8.2*/8.0	310*/320	.01	<.01	.14	.01	.02	3.4%	.000	210	170	<1	<1	2	210			4
P-2	Paye Creek, Downstream	6/21	1410	3.6	9.6*	95.0%	12.4*	8.2*/8.2	302*/352	.02	<.01	.22	.02	.03	4.3%	.001	220	140	7	2	2	320 Est.			7
STP-U	Chewelah STP	6/20			2.7*	30.1%	18.0*	8.0*	551*																
	Unchlorinated Effluent	6/21			3.4*	38.0%	18.2*	8.0*	520*																
		6/20-21	Comp	.63				8.1	650*/612	3.6	.05	.05	1.1	1.2	4.2%	.150	400	290	4	2	3			5 Est.	42
STP-C	Chewelah STP	6/20		.56			17.8*	7.9*	520*													<1	2.5		
	Chlorinated Effluent	6/21					17.9*		575*													6 Est.	1.0		
		6/20-21	Comp	.63				8.1	620*/610	3.9	<.05	.25	1.10	1.30	4.1%	.160	440							7 Est.	38
Co-1	Colville River at 395 Br.	6/20	1700		12.4*	132%	15.8*	8.2*	339*																
		6/21	1540	(77)	11.1*	117.4%	15.5*	8.6*/8.4	345*/311	.02	<.01	.25	.02	.02	10.2%	.002	230	190	12	8	6	120			14
Co-2	Colville R. at Kalvano Br.	6/20	1740		11.6*	120.4%	14.6*	8.5*	250*																
		6/21	1605	(120)	10.9*	114.1%	15.0*	8.6*/8.4	251*/263	.02	<.01	.27	.02	.04	9.8%	.002	190	160	18	12	8	86			14
Co-3	Colville R. at Steinmetz Br.	6/20	1800		11.0*	114.4%	14.7*	8.5*	251*																
		6/21	1630	(125)	10.9*	115.3%	15.5*	8.6*/8.4	270*/265	.03	<.01	.25	.02	.04	10.2%	.003	180	140	13	8	7	64			14
Co-4	Colville R. at Unnamed Br.	6/21	1700	(125)	10.3*	108.0%	15.1*	8.5*/8.3	280*/268	.04	<.01	.22	.04	.04	8.0%	.003	220	150	16	12	8				14

* = Field analysis
Est = Estimate
( ) = Flow based on balance calculations. Flow of Colville River measured at 124 cfs between Paye Creek and treatment plant outfall.

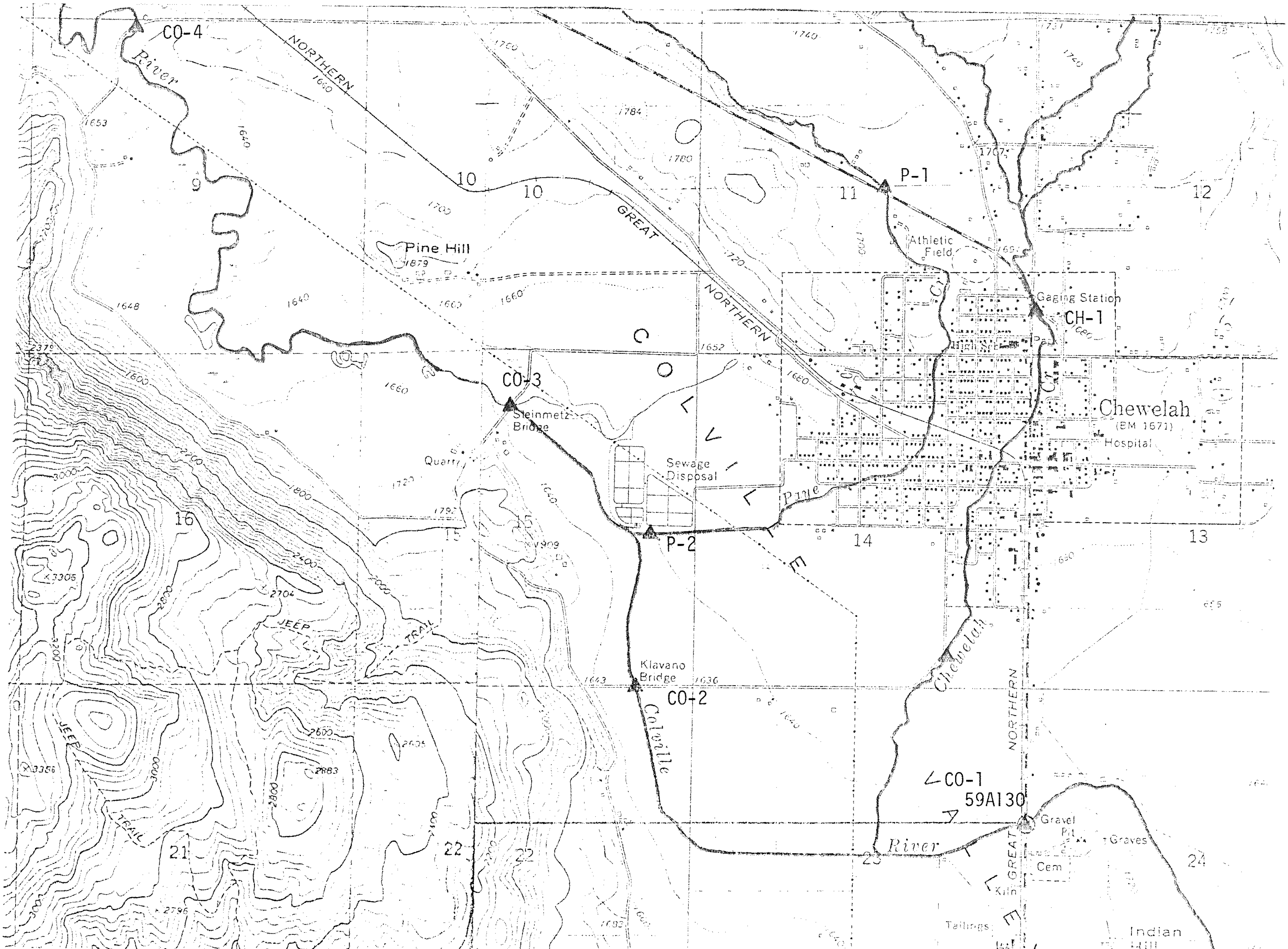

Figure 3. Study area; Colville River Drainage in vicinity of Chewelah, Washington.

obtained in the Colville River between Paye Creek and the Chewelah WTP outfall. This flow was 124 cfs. Treatment plant flow was obtained as described in Part I using a Manning "Dipper" meter located at a 12-inch throat with Parshall flume at the plant influent. Estimated flows were obtained for the remaining stations by difference.

Results

Although this survey was scheduled with the intent of encountering relatively low river flows, a wet spring and cool summer resulted in relatively high flows at the time of the survey. To place the Colville River flow during this survey in some perspective, it is compared in Table 8 to various low flows in the Colville River at Blue Creek (about five miles downstream from the Chewelah WTP discharge and prior to input from any major additional tributaries). The low-flow data were obtained from a USGS open-file report (Scott, 1969). Also included in Table 8 is a comparison of dilution ratios (river flow:plant flow) at the various receiving water flows.

Table 8. Comparison of Colville River flows:survey flow vs. low flows.

Location	Low Flow Duration & Recurrence Interval	Flow (cfs)	Dilution Ratio Based on WTP Flow of .41 MGD
Colville River below Chewelah WTP	-flow during survey-	125	197:1
Colville River at Blue Creek	-7 day, 5 year-	25.9[1/]	41:1
Colville River at Blue Creek	-7 day, 10 year-	19.0[1/]	30:1
Colville River at Blue Creek	-7 day, 20 year-	12.7[1/]	20:1

[1/] Scott, 1969.

It is apparent from Table 8 that the dilution ratio observed during the survey was quite high. Detection of significant receiving water effects when dilution ratios exceed about 50:1 is difficult. It is also worth noting that during a 7-day, 10-year low flow, the Chewelah plant is beginning to approach the 20:1 dilution ratio limitation (WDOE, 1978). Based on the 7-day, 10-year flow referenced here, a maximum permissible flow from the Chewelah facility would be about 0.60 MGD.

As one would expect from the relatively high dilution ratio, the Chewelah effluent appeared to be having little significant impact on the Colville River during the survey. In addition, neither Chewelah Creek nor Paye Creek appeared to be significantly degraded as they passed through Chewelah.

To provide some perspective on the potential impact of the current discharge on the Colville River during periods of low flow, Table 9 is included. Table 9 presents ranges of water quality measurements recorded at the Colville River at Chewelah ambient station (59A130, CO-1) monitored by WDOE during water year 1976. Ranges are those recorded during the potential low flow months of June to September. Based on a 7-day, 10-year low flow of about 19 cfs, a plant flow of .4 MGD and the effluent quality characterized during this survey, Table 9 presents the theoretical changes in Colville River quality potentially attributable to the Chewelah plant effluent. These changes are presented both as concentration changes and percent changes.

Table 9. Potential Chewelah WTP effluent impacts on the Colville River during a 7-day, 10-year low flow (dilution ratio of 30:1).

Water Quality Parameter	Receiving Water Range[1]	Concentration Change Attributable to Chewelah Effluent	Percent Change Attributable to Chewelah Effluent
Dissolved Oxygen (mg/L)	8.0-10.0	- .17 to .23	- 2%
Spec. Cond. (μmhos/cm)	250-325	+ 9 to 12	+ 4 to 5%
NH_3-N (mg/L)	.05-.11	+ .11 to .13	+ 200 to 300%
NO_2+NO_3-N (mg/L)	.04-.20	- .003 to + .007	- 2 to 20%
Total-Inorg-N (mg/L)	.16-.29	+ .12	+ 40 to 75%
Total-P (mg/L)	.02-.05	+ .04	+ 50 to 200%
Total Chl. Resid. (mg/L)	*	+ .03 to .08	∞

[1]See text.
* = Not monitored; assume equal to 0.

Based on Table 9, the Chewelah discharge could be responsible for significant increases in nutrient (nitrogen and phosphorus) and residual chlorine concentrations in the river under conditions of low river flow. Increase in in-stream nutrient concentrations would potentially stimulate primary productivity (algal growth) downstream. Potential total residual chlorine (TRC) concentrations of .03 to .08 mg/L raise the concern of in-stream toxicity to aquatic life. These concentrations are 15 to 40 times higher than the EPA receiving water criterion of .002 mg/L.

As a first step in resolving the potential chlorine residual problems in the river, Chewelah personnel should be urged to maintain chlorine concentrations between the 0.1 and 0.5 mg/L concentrations specified in the order.

During the plant inspection, an effluent TRC of 2.5 mg/L was measured. A fecal coliform sample collected concurrently with the analysis yielded a count of <1/100 mLs. Plant personnel were asked to decrease the rate of chlorine feed and subsequent analyses yield a TCR of 1.0 mg/L and an estimated fecal coliform count of 6/100 mLs -- still well below the permit limit of 200/100 mLs. It is very likely that adequate disinfection could be achieved with a TCR of less than 0.5 mg/L. This would substantially decrease the risk to aquatic organisms in the vicinity of the outfall. This is particularly important as this stretch of the Colville River is used extensively by fishermen. Several parties of anglers fishing for brown and brook trout were encountered along the river during the survey.

Conclusions and Recommendations

1. Colville River flow was well above critical low flow during the survey. This resulted in a dilution ratio for Chewelah WTP effluent of about 200:1, compared to a dilution ratio of about 30:1 during a 7-day, 10-year low flow.

2. Because of the high dilution ratio experienced during the survey, the effluent had little apparent impact on the receiving waters.

3. Under conditions of low river flow, the most likely impacts of the Chewelah WTP are: (a) increases in receiving water nutrients; and (b) potentially toxic concentrations of total chlorine residual.

4. To minimize the adverse impacts of chlorine on the receiving water, effluent chlorine residual concentration should be maintained between 0.1 and 0.5 mg/L as specified in the order (see Part I).

BY:cp

Attachments